Sustainable Land Management for Reclaimed Farms in Egypt: "DINA Integrated Farms"

M. Shawki Elghazali * Ashraf Nasr Yasser Eimanadili ****

* Professor, Civil Engineering Department, Cairo University, Giza, Egypt
** Assistant Professor, Civil Engineering Depanmeilt, Cairo University, Giza, Egypt
E-mail : globalgb@egyptonline.com

1. Abstract

Technology and technological change are important forces that shape the economy. The concept of sustainable resources management requires a solid understanding of the ecological and sociologic ramifications of alternative management actions.

Traditional GIS applications such as in the area of utilities and urban planning have widely been implemented in Egypt during the past five years. Recently, more innovative GIS applications have emerged in non-conventional disciplines such as the area of construction management and farming.

The theme of this paper will be the planned development of a reclaimed farm - DINA Integrated Farms, Osman Group – and a resources management decision support system with sufficient capability to evaluate changes and serve as a tool for facility management. Dina Farm is the largest private farm totaling an area of approximately 4000 hectares. The farm hosts various activities such as agriculture, animal husbandry, agroindustdal, and commercial activities. It also has a social sporting club, a motel, residential and tourist resort all served by a huge infrastructure network. A PC-based GIS solution using ESRI, ARCVIEW software is utilized to manage and control all activities and resources within the farm. It also offers the possibility to optimize farm return and minimize chemical inputs and environmental hazards. The paper focuses on the characteristics of the proposed system and its different implementation stages.

2. Introduction

DINA Integrated Farm is one of the largest private desert land reclamation projects in Egypt. It is located along the Cairo - Alexandria desert road, 80 Km away from Cairo. The area of the farm is approximately 4,000 hectares. Many types of crops are cultivated in the farm, such as Potatoes, Tomatoes, Mangos, Bananas, and Grapes. Animal production is one of the main interests of the farm's owners and managers, with various related meat and dairy products. The farm is equips with a hotel, housing and living accommodations, social club, stadium and sports facilities, and touristic villages. The whole project is served by a huge infrastructure network, including more than 50 Km of roads, power stations and electrical lines, as well as deep wells and water pumping plants connected with dripping and sprinkling irrigation systems.

Since its establishment, the most recent technological facilities have been utilized in DINA. It began with an intensive geological and biochemical analysis of the soil and work under-ground water assessment. The project's experts continue to monitor weather conditions, use the most

advanced irrigation system and the finest types of seeds, select the best world cow breads, and employ advanced management techniques in the farm's factories.

This kind of (huge) project must essentially have a very sophisticated management system of land resources, equipment, and manpower to achieve the highest profit-to-cost ratio. In this new era of information technology, hardware and software no longer limit the implementation of new approaches to farm, crop, soil, and utility management. Geographic Information Systems (GIS) and powerful Data Base Management Systems (DBMS) are advanced technology that can efficiently handle the management of this kind of projects. GIS is a computer assisted system for the acquisition, storage, analysis, and display of geographic (land related) data. GIS software allows for merging various types of data with specific locations on a map. Data of different format, images, attributes and charts, can be superimposed and linked to their exact location in order to be easily manipulated, processed, and analyzed using GIS software.

The objective of applying GIS technology in DINA Integrated Farm was aimed towards achieving the following goals:

- A complete set of up-to-date digital maps of DINA Integrated Farm at different scales attached to a comprehensive database for all parts of the farm
- Color paper prints and transparency drawings.
- Complete reports about all parts of the farm.
- A powerful GIS analysis, including: time series analysis, change detection in under-ground water depth, water and soil characteristics, animal production rates, crop suitability maps, buffering analysis,.. etc.
- A comprehensive management system of human resources.
- A Complete management system of all equipment, and all existing facilities.

3. Procedures

Building a GIS for DINA Integrated Farm involved some quite sophisticated computer software and hardware, which covered the following major components:

- A data input subsystem which collects and/or processes spatial data as well as attribute data derived from existing maps, reports, sensors, etc.
- A data storage and retrieval subsystem which organizes the spatial and attribute data in a form which permits it to be quickly retrieved by the user for subsequent analysis, as well as permitting rapid and accurate updates and corrections to be made to the database.
- A data manipulation and analysis subsystem that performs a variety of tasks such as changing the form of the data through user-defined rules or simulation models.
- A data reporting subsystem which is capable of displaying all or part of the original database as well as manipulated data and the output from spatial models in tabular or map form.

This procedure was performed in stages and according to a predetermined schedule to coincide with the implementation steps. The project started by arranging meetings with DINA personnel to define and assess user needs and to determine sources and types of data and information needed for building a complete GIS. Upon defining the data and information available for DINA Integrated Farm including all graphical data (maps of different scales, photographs, charts ..... etc.) and all attribute data (all information attached to each geographic position inside the farm), the acquisition process was performed using different surveying techniques. In some stages, GPS receivers were

used to establish the locations of farm boundaries. Data and information available for DINA Integrated Farm concerning the manpower working on the Farm as well as all buildings, equipment, utilities, and all facilities inside the Farm were also acquired. The collected data were then transformed into digital form. The transformation of data from graphical format to digital format was accomplished using digitizers in order to prepare these data for further manipulation, analysis, and display. The collected data had to be inspected, tested, and screened to assure accuracy and completeness of the information before going further into any analysis process. Acquiring new data was needed in this stage to recover the missing information. Building topology for the geographic data was performed using the ARC/INFO software package (a powerful GIS software), in which all points, lines, and polygons were defined.

The following step was to build a database system using the collected attribute data and attach the geographic data collected in a previous stage using the ARCVIEW software package. Numerous types of analysis were then performed in order to satisfy the client's needs. Different queries covering statistical analysis on the activities inside the Farm were built. The results were presented in the form of tables that include the information about the query under investigation, or in the form of graphical charts representing the relationships between different parameters that influence the query.

4. Results

The results of applying GIS to DINA Farms project were tremendously encouraging. A complete set of up-to-date digital maps of DINA farms that show different levels of detail, attached to a comprehensive database for all parts of the farm, were produced. It included the following geographic sets for housing and living accommodations, factories, storage places, workshops, sports facilities, administration buildings, animal production places, and pivots. Digital maps of soil classes and soil characteristics were prepared to study the impact of soil type on the farm productivity. Moreover, digital maps of the ground water table and soil profiles were produced to detect any changes in the underground water resources and any alteration in the water characteristics that make the water unusable for irrigation purposes. Digital maps for all utilities such as power lines, water lines, gas, and telephones were produced to apply different networking analysis techniques. These maps can be displayed all together or separately, according to the application under investigation with the capability of accessing the attached databases. The powerful zooming and intelligent capabilities of the system allow the user to control the level of detail that is shown as different map scales. This can range from a general layout that contains only the main features of the farm up to the internal details of each building at the largest scale.

The power of any GIS is demonstrated by its ability to perform very strong and complicated analysis. A complete analysis based on time series was conducted to detect changes in the underground water depth and soil characteristics. Statistical analysis for animal production rates and crop yields were conducted to assess the profitability of the project. Moreover, a comprehensive management system of manpower resources and equipment was designed to monitor all activities within the Farm. The database for the manpower resources module contained full information about each employee, including, ID number, name, age, hiring date, level of education, job, experience, salary, place of work, etc. The database of the equipment module contained information about the equipment: type, date of purchase, initial and running costs, maintenance dates and procedure, rate of working performance, related personnel, etc. Various types of analysis were accomplished using these databases. Color paper prints and transparency drawings of any data set or all of them together at any desired scale were produced by the project.

5. Conclusions

Farm management may take place at the micro and macro level. Precision farming should integrate all technical and economic aspects of agriculture as well as additional activities within the farm. This means that a variety of technologies must be brought under the precision-farming umbrella.

Precision farming provides a sustainable agricultural system that allows farmers to use resources efficiently, and develop and maintain complete input and output records. It is a knowledge-based technical management system capable of optimizing farm profit and minimizing agriculture's impact on the environment.

6. Acknowledgement

The authors would like to acknowledge the use of hardware (workstations, digitizers, scanners & PC's) as well as ESRI software packages (ARC/INFO & ARCVIEW) of Global Geobits-Egypt for Geographic Information Systems, Osman Group Company. The authors would like also to express their gratitude to Dina lntegrated Farms Cornpany for supplying the data and supporting this project.

7. References

Clark R.."Practices and Potential: Assessing an Agricultural Revolution in Progress", Supplement to CTPS World Magazine, April 1997.

Gibbons 0., GPS : putting the Precision into Farming", Supplement to GPS World Magazine, April 1997.

Giraut M., "GIS Methodology Applied to Water Resources Management in Argentina's Territory"', 17 'h Annual ESRI User Conference, July 1997.